# TEST AND EVALUATION RESOURCES

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# Test and Evaluation Resources

| Key Takeaways | |
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| **Department of the Army** | • Continued investment in **distributed range capabilities** will support efficient and scalable testing of networked sensor-to-shooter kill chains.<br>• **Availability of advanced threat surrogates** (e.g., armor, electronic warfare threat emulators) will enable representative testing of land warfare systems.<br>• **Advanced open-air and digital range capabilities** will enable dynamic and efficient testing of networks and system-of-systems events.<br>• Developers and technical subject matter experts will improve the use of **digital environments** in test planning and execution. |
| **Department of the Navy** | • Availability of **accurate test surrogates** (e.g., threat submarines, ships, and aircraft; modern threat jammers; threat missiles and torpedoes, digital threat simulators) will enable representative testing of naval warfare systems.<br>• **Integration of digital threat representation within test ranges** will provide adequate support of live-virtual-constructive end-to-end system evaluation (e.g., electromagnetic spectrum offensive and defensive capabilities).<br>• **Continuous updates and associated continuous verification, validation, and accreditation (VV&A)** of the Joint Simulation Environment (JSE)[1] will support effective T&E of new air warfare systems. |
| **Department of the Air Force** | • New and updated live data will enable accurate **VV&A of high-fidelity digital tools** of blue and red platforms, sensors, and weapon systems including space-based capabilities.<br>• **Updates to range threats, instrumentation, and connectivity** will improve the development and testing of emerging technologies including space-based systems (i.e., open air ranges require high fidelity class of capability emulators, and hardware-in-the-loop facilities lack dynamic, direct-inject simulation of threat infrared (IR) signatures).<br>• **Continuous updates and associated continuous VV&A** of the JSE will support effective T&E of new air warfare systems. |
| **Multi-Service** | • **Improved throughput, capacity, and capabilities of test ranges** including advanced data collection will enable the evaluation of emerging technologies including long-range weapons, autonomous, and artificial intelligence (AI)-enabled systems, and against **realistic electronic warfare threats**.<br>• **Big data centers, data management infrastructure, and appropriate classified networks and workstations** in Sensitive Compartmented Information Facilities (SCIFs) will increase efficiencies across the T&E enterprise including DOT&E.<br>• **Automated test tools** including those for software, **cyber**, AI, and integrated T&E will enable testing of complex weapon systems at scale and speed.<br>• **A qualified workforce** including NSA-certified Red Teams and personnel with expertise in digital engineering, software, electronic warfare, AI, big data science, space operations, will help the T&E enterprise meet emerging T&E needs. |

1 JSE is a multi-service, scalable, expandible, high-fidelity, government-owned, non-proprietary modeling and simulation (M&S) environment to conduct testing on fifth-plus generation aircraft and systems as a supplement to open-air testing.

# DEPARTMENT OF THE ARMY

DOT&E oversees a subset of DoD systems and services intended to support land and expeditionary warfare including the newest military vehicles, ground weapons systems, rotary wing aircraft, communications systems, and missile systems to include hypersonics. To support adequate evaluation of such systems, DOT&E has identified the following T&E resources requirements.[1]

## » REQUIRED RESOURCES

- Increased production of Intelligence Community-based threat models of contemporary Russian and Chinese electronic warfare systems, and radio-based communication systems to test emerging Army sensors and offensive capabilities.
- Advanced adversary armor systems to assist in the development of armor surrogates and models.
- Adversary active protection systems to support the evaluation of operational effectiveness and lethality of Army weapon systems.
- Accredited digital environments and tools to support testing of mission threads and other system-of-systems architectures.
- Real-time casualty assessment capability to support evaluation of casualties due to blast effects on walls and bunkers.
- Equipment updates to capture and distribute audio-visual test data.
- An open-air range to support short- to long-range artillery engagements, in representative contested environments, with various munitions.
- Test ranges authorized to conduct open-air end-to-end lethality tests using depleted uranium rounds.
- Upgraded test fixtures and chemical testing referee systems to provide near real-time continuous air monitoring.
- Initiatives in test capabilities to support the testing of the new chemical, biological, nuclear, and radiological warfare protective suit.

# DEPARTMENT OF THE NAVY

DOT&E oversees a subset of DoD systems and services intended to support naval warfare including amphibious systems, the newest surface and undersea naval warfare systems, naval airborne platforms, uncrewed systems, and missiles to include hypersonics. To support adequate evaluation of such systems, DOT&E has identified the following T&E resources requirements:

## » REQUIRED RESOURCES

- Accurate test surrogates representing threat submarines, ships, and aircraft; modern threat jammers; and threat missiles and torpedoes.
- Threat surrogates for multi-stage anti-ship cruise missiles and large tactical aircraft.
- Additional aerial targets that respond to soft-kill defenses, multi-stage supersonic target, and standoff jammer aircraft.
- Submarine-representative set-to-hit torpedo target surrogate.
- Additional mobile ship targets to support the capacity of anti-ship missile testing.
- Synthetic undersea environment for unmanned undersea vehicles (UUVs) interoperable with other environments for multi-domain testing.
- Undersea threat emulators including countermeasures, torpedoes, and small (coastal/midget) submarines.
- Test ranges capable of testing the vulnerability of systems to emerging threats (i.e., hypersonics, UUVs).
- Digital threat representation integrated within test ranges supporting live-virtual-constructive end-

1 T&E resources include test facilities; instrumentation; equipment; ranges; tools; threats; targets; test assets; interfacing systems; digital tools and their VV&A; test teams; related support (e.g., friendly and threat operational forces, data collectors, analysts, subject matter experts); digital technologies (e.g., data repository); training materials; Federal, State, and local requirements; funding needed to plan, execute, and report on OT&E and LFT&E.

to-end system evaluation (e.g., electromagnetic spectrum offensive and defensive capability, scalable threat cruise missile representation, threat kinetic and non-kinetic self-defense systems including emerging capabilities).

- Representative naval topside electronics, emitters, and weapons systems for destructive testing.
- Increased capability and capacity in support of shock-hardened equipment testing.
- Faster small boat threat surrogates for destructive live fire test events.

## DEPARTMENT OF THE AIR FORCE

DOT&E oversees a subset of DoD systems and services intended to support air warfare including fighters, bombers, mobility aircraft, rotary wing aircraft, airspace battle management, air-to-air, air-to-ground, and hypersonic weapons. To support adequate evaluation of such systems, DOT&E has identified the following T&E resources requirements:

### » REQUIRED RESOURCES

- Advanced threat environments at ranges (including but not limited to, Nevada Test and Training Range, Point Mugu Sea Range) and enough throughput and connectivity to support testing and evaluation of complex mission scenarios, hypersonic, and force-on-force testing with Open-Air Battle Shaping (OABS), which integrates USAF and USN instrumentation systems.
- A dedicated Space Force range for electronic warfare testing with additional space-specific testing capabilities.
- Enhanced virtual environments and M&S capabilities to test on-orbit threats.
- Availability of operational terminals and systems.
- Capabilities (e.g., blue unmanned aircraft systems) to enable live testing of infrared missile warning systems and directed countermeasures.
- Qualified, specialized personnel to operate the test assets, analyze, and conduct tests on new space systems and technologies.

## MULTI-SERVICE T&E RESOURCES

Common to systems and services across all Services, DOT&E has identified the following T&E resources requirements:

### » REQUIRED RESOURCES

- Test ranges with enough throughput and capability of supporting the testing of several long-range missiles with telemetry and flight termination packages (e.g., Stand-in Attack Weapon, long-range fires, hypersonic weapons).
- Rapid and agile delivery of new and updated threat models informed by the intelligence community including class-of-capability radar and electronic attack emulator systems that can be programmed to stay ahead of the emerging threat and be tied into the range with OABS.
- Modern aerial targets (e.g., fourth- and fifth-generation fighter aircraft, large bomber and mobility aircraft, helicopters, electronic warfare, ground-based radars, airborne threat, software-defined radars, radio frequency and physical decoys, surface-to-air missiles, hypersonic missiles, and other emerging technologies and threat weapons).
- Capability to test representative densities and complex scenarios in anechoic chambers, hardware-in-the-loop labs, hybrid (digital range) environments, and open air test ranges.
- A facility to emulate modern radio frequency threats.
- High-fidelity cockpit, avionics, and weapons simulations of current and emerging red and blue aircraft delivered in time for integration into the Joint Simulation Environment (JSE) with full verification, validation, and accreditation (VV&A).

- A continuous VV&A process that enables the high-fidelity JSE to keep up with constant changes to platform, weapon, and battlespace entities.
- Additional, higher-fidelity and accredited live virtual constructive test environments.
- Multi-domain red and blue platforms, sensors, weapons modeling and simulation (M&S), and constructive effects that are tied into OABS via multi-level secure networks for testing of complex scenarios with representative long- and short-range kill chains.
- Capacity and certification to conduct frequent and simultaneous GPS jamming and spoofing across multiple test ranges.
- Missile defense capabilities including jamming equipment found on adversary ballistic missiles.
- Automated test tools including those for software, cyber, artificial intelligence (AI), and integrated T&E.
- Ability to conduct complex AI data collection and reduction, including infrastructure, tools, and personnel. AI software development tools and services to load, build, and test the various AI models.
- Improved capability to network open-air and ground test facilities to mirror an operational Combined Joint All-Domain Command and Control (C-JADC2) environment.
- Big data centers, data management infrastructure, and appropriate classified networks and workstations in SCI facilities across the T&E enterprise, including DOT&E.
- High-performance computing and high bandwidth and low-latency data transfer network architectures to support T&E data management challenges, compliance with the DoD Data Management Strategy, and the implementation of emerging digital tool capabilities for high-level mission effects analyses.
- Integrated data analytics to conduct data fusion and create a common operating picture from multiple sensors or ranges.
- Model-based engineering baseline for future digital T&E campaigns informed by live, virtual, and constructive testing.
- Capability to test and analyze failure modes on nuclear components and systems following extreme environment tests.
- Joint interface testing, electronics testing, performance assessment, and fault analysis when integrating system- and box-level nuclear test units.
- Electromagnetic pulse test capabilities for survivability and lethality evaluations.
- Range sustainability related to mitigation of any adverse effects due to off-shore wind-turbine generation impacting test ranges and T&E activities.
- Range sustainability related to detailed transition plans to address decreases in spectrum availability for test and training due to recent 5G-related sell-offs (including S- and L-bands) to commercial industry.
- A cyber-qualified workforce – including NSA-certified Red Teams – to keep pace with the increasing complexity and scale of cyber survivability testing. Increased cyber expertise in aggressing non-Internet Protocol networks and systems, identifying unauthorized users and spoofing attempts, assessing radio frequency data links, and supporting convergence of cyber and electromagnetic spectrum operations.
- Personnel across the OT&E and LFT&E enterprise with expertise in M&S, digital engineering, model-based systems engineering, electronic warfare, software, AI, and machine learning.